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Significance Determination Process
Lesson Plan

I. Introductory Material

A. <u>Purpose of SDP</u> - The Significance Determination Process (SDP), uses risk insights where appropriate, to help the NRC inspectors and staff to determine the safety significance of inspection findings.

B. <u>SDP Objectives</u>

1. To characterize the significance of an inspection finding for the NRC licensee performance assessment process, using risk insights as appropriate.
   a. The SDP assigns a color to the inspection finding.
      A. Green - a finding of very low safety significance. *(IMC-0612)*
      B. White - a finding of low to moderate safety significance. *(IMC-0612)*
      C. Yellow - a finding of substantial safety significance. *(IMC-0612)*
      D. Red - a finding of high safety significance. *(IMC-0612)*
   b. The inspection finding colors are combined with the performance indicator colors for use in the assessment of the utility's performance.
2. To provide all stakeholders an objective and common framework for communicating the potential safety significance of inspection findings.
   a. Stakeholders: public, utility and its owners, utility organizations, and the NRC.
   b. Safety significance is defined by the color of the inspection finding.
3. To provide a basis for assessment and/or enforcement actions associated with an inspection finding.
   a. Green findings are non-cited violations and turned over to the utility for resolution via the corrective action program.
   b. Notices of violation are issued for greater than green findings.
4. To provide inspectors with plant-specific risk information for use in risk-informing the inspection program.
   a. Risk-informing the inspection program focuses limited resources on more safety significant issues.

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b. SDPs should help the inspectors determine safety significance of plant SSCs.

C. Types of SDPs

1. At least one SDP supports each cornerstone associated with the strategic performance areas as defined in Inspection Manual Chapter 2515.
   a. Initiating Events
   b. Mitigating Systems
   c. Barrier Integrity
   d. Emergency Preparedness
   e. Public Radiation Safety
   f. Occupational Radiation Safety
   g. Physical Protection
2. SDPs
   a. Significance Determination of Reactor Inspections for At-Power Situations
   b. Emergency Preparedness SDP
   c. Occupational Radiation Safety SDP
   d. Public Radiation Safety SDP
   e. Physical Protection SDP
   f. Fire Protection and Post-Fire Safe Shutdown SDP
   g. Shutdown Safety SDP
   h. Containment Integrity SDP
   i. Operator Requalification, Human Performance
3. The SDPs and related instructions are found in IMC-0609. The individual SDPs are appendices to IMC-0609. *(The appendix letters are identical to the letters used above.)*
4. This presentation is associated with the Significance Determination of Reactor Inspections for At-Power Situations.

II At Power SDP Introduction.

A. Entry Conditions

1. This SDP provides a simplified risk-informed framework to estimate the increase in core damage frequency during at-power operations due to conditions which contribute to unintended risk increases caused by deficient licensee performance.

   a. Deficient licensee performance or performance deficiency is an issue that resulted in not meeting a requirement or standard whose cause was reasonably within the licensee's ability to foresee and correct, and which should have been prevented.

   b. Examples of deficient licensee performance include: safety-related pump discharge valves remaining closed following surveillance testing, debris left in safety-related tanks, and failing to take proper corrective action when testing demonstrated a problem area.

   c. Conditions which do not represent deficient licensee performance are considered part of the acceptable plant normal operating risk, and are not candidates for SDP evaluation.

2. Each issue should first be screened by using IMC 0612, Appendix B, to determine whether or not the issue is a minor issue.

B. Minor Issues

1. Minor Questions from IMC 0612.

   a. Could the finding be reasonably viewed as a precursor to a significant event?

   b. If left uncorrected, would the finding become a more significant safety concern?

   c. Does the finding relate to performance indicators that would have caused the PI to exceed a threshold?

   d. Is the finding associated with cornerstone attributes and does the finding affect the associated cornerstone objective?

   e. A NO answer to all questions implies that the issue is minor.

C. Cornerstone Objectives and Attributes for At-Power SDP *(IMC 0612)*

1. Initiating Events Objective: to limit the likelihood of those events that upset plant stability and challenge critical safety functions during shutdown as well as power operations.
2. Initiating Events Attributes: Design Control, Protection against external factors, configuration control, equipment performance, procedure quality, and human performance.
3. Mitigating Systems Objective: to ensue the availability, reliability, and capability of systems to respond to initiating events to prevent undesirable consequences (i.e., core damage).
4. Mitigating Systems Attributes: Design Control, Protection against external factors, configuration control, equipment performance, procedure quality, and human performance.
5. Barrier Integrity Objective: to provide reasonable assurance that physical design barriers (fuel cladding, RCS, and containment) protect the public from radio nuclide releases caused by accidents or events.
6. Barrier Integrity Attributes: Design Control, cladding performance, configuration control, equipment performance, procedure quality, human performance, RCS equipment and barrier performance, and SSC and barrier performance.
7. If an attribute is affected, then the question "can the finding be evaluated using the SDP?" is asked.

D. Can the finding be evaluated using the SDP questions *(IMC 0612)*

1. Is the finding associated with an increase in the likelihood of an initiating event?
2. Is the finding associated with the operability, availability, reliability or function of a system or train in a mitigating system?
3. Is the finding associated with the integrity of fuel cladding, the reactor coolant system, reactor containment or control room envelope?

4. Is the finding associated with a degraded condition that could concurrently influence any mitigation equipment and an initiating event?
5. Is the finding associated with or involve impairment or degradation of a fire protection feature? *(Assessed with Fire Protection SDP).*
6. If these questions are answered with NO, consult management. If these questions are answered with a YES, go to the SDP.
7. As a special note, the SDP should not be used for events assessment.

III. SDP Phases

A. The plant-specific reactor safety SDP uses a graduated three-phase process to differentiate inspection findings on the basis of their potential risk significance. The staff's final determination may be based on any of these three phases.

B. **Phase 1 - Characterization and Initial Screening of Findings:** Characterization of the finding and an initial screening of low-significance findings for disposition by the licensee's corrective action program.

C. **Phase 2 - Risk Significance Estimation and Justification Using the Site Specific Risk-Informed Inspection Notebook:** Plant-specific estimation of the risk significance of an inspection finding and development of the basis for the determination.

D. **Phase 3 - Risk Significance Estimation Using Any Risk Basis That Departs from the Phase 1 or 2 Process:** Any departure from the guidance provided for phase 1 or 2 constitutes a Phase 3 analysis. Phase 3 analysis methods will utilize appropriate PRA techniques and rely on the expertise of NRC risk analysts.

IV SDP Procedure Using an Example *(BWR differences will be bolded).*

A. Issue - While performing a complete system walkdown of the high head safety injection (HHSI) **high pressure coolant injection [HPCI]** system in accordance with Inspection Procedure 71111.04, "Equipment Alignment," an inspector identified that a normally locked open manual valve in the discharge flow path of one train**(of the system)** was closed. The valve position for this valve was not indicated in the control room. This valve was also not in the flow path during quarterly surveillance testing of the system. It was subsequently determined that the valve had been out of position since maintenance was last performed on the system ten months prior. The inspectors determined that the criteria for crediting operator recovery of the HHSI train **[HPCI]** were satisfied and that credit for recovery of the train was appropriate.

A. Issue Disposition Using IMC 0612 Appendix B

1. Could the finding be reasonably viewed as a precursor to a significant event? The pump is a mitigating system , and its inoperability cannot initiate an event. Therefore, the answer to this question is NO.
2. If left uncorrected, would the finding become a more significant safety concern? The longer the condition exists, the greater the probability of an event requiring mitigation by this pump. Therefore, the safety significance increases, so this question should be answered YES. It should be noted that some individuals view this question as a corrective action question. For example, consider moisture intrusion into the instrument air system. The longer the condition is allowed to exist (without corrective action), the greater the probability of plugging bleed ports on valves, etc., with rust caused by the moisture in the system.
3. Does the finding relate to performance indicators that would have caused the PI to exceed a threshold? Strictly speaking, the answer to this question might be YES because the Safety System Unavailability PI is affected, but PI calculation is not the purpose of this presentation.
4. Is the finding associated with cornerstone attributes and does the finding affect the associated cornerstone objective? The answer to this question is found by examining the objective for the mitigating system cornerstone. The objective is to ensue the availability, reliability, and capability of systems to respond to initiating events to prevent undesirable consequences (i.e., core damage), and this pump certainly can't respond. So, the answer is YES. The affected attributes may be procedural quality if the surveillance procedure failed to restore the system correctly following testing, or human performance could be involved.

5. It should be noted that if the answer to any of these questions is YES, the questions concerning use of the SDP should be examined. All questions were covered in this presentation for completeness.
6. SDP Questions
   A. Is the finding associated with an increase in the likelihood of an initiating event? NO. The pump is a mitigating system , and its inoperability cannot initiate an event.
   B. Is the finding associated with the operability, availability, reliability or function of a system or train in a mitigating system? YES.
   C. Is the finding associated with the integrity of fuel cladding, the reactor coolant system, reactor containment or control room envelope? NO.
   D. Is the finding associated with a degraded condition that could concurrently influence any mitigation equipment and an initiating event? NO.
   E. Is the finding associated with or involve impairment or degradation of a fire protection feature? NO.
   F. The instructor may want to let the students answer these questions to check understanding.
   G. A YES answer to question b implies that the SDP can be used.

A. Phase 1 Instructions
   1. **Step 1.1 - Definition of the Inspection Finding and Assumed Impact** Using the <u>Phase 1 Worksheet</u>, state the performance deficiency and factually describe the known observations associated with the issue. Describe the assumed impact on affected plant safety functions. Do not include hypothetical conditions (e.g., single failure criteria). A bounding determination of significance may be made by assuming a worst-case condition (e.g., assume complete loss of function, even if unsupported by the facts known at that time). If a bounding determination results in greater than green, greater factual detail will be necessary to complete the SDP.
   2. Because the purpose of the SDP is to estimate the increase in core damage frequency due to deficient licensee performance, the SDP evaluation should

not include equipment unavailability due to planned maintenance and testing. The impact of this equipment not being available for mitigation purposes is included in the baseline core damage frequency for each plant.

3. The issue described earlier would be placed in the first section of Phase 1 worksheet Page 1.
4. System(s) and train(s) degraded by identified condition HHSI and the applicable train or **HPCI** would be entered in this space.
5. Licensing Basis Function of System(s) or Train(s) (as applicable): RCS Inventory Control during a small break loss of coolant accident.
   A. FSAR contains design basis information
   B. Technical Specifications contain design basis information.
6. Other Safety Function of System(s) or Train(s) (as applicable): Feed and Bleed core cooling during losses of all feedwater events. **BWR Instructors may add additional functions here.**
7. Maintenance Rule Category. (New students should be told that the maintenance rule can be found in 10CFR50.65). The pump is risk-significant for both reactor designs.
8. Time that identified condition existed or is assumed to have existed: From the given scenario, the pump has been inoperable for 10 months.
   A. This information will be required in future steps. For example, the Initiating Event Likelihood.
   B. From Attachment 2, Site Specific Risk-Informed Inspection Notebook Usage Rules: " The exposure time used in determining the Initiating Event Likelihood should correspond to the time period that the condition assessed is reasonably known to have existed. If the inception of the condition is unknown, then an exposure time of one-half of the time period since the last successful demonstration of the component or function (t/2) should be used."

9. **Functions and Cornerstones degraded as a result of this identified condition (check ✓).**
   A. The inoperability of the pump will not cause an initiating event.
   B. The inoperability of the pump will not immediately affect the barrier cornerstone. *(Remind the students of the statement about hypothetical failures found along side the Factual Description of Identified Condition.)*
   C. Mitigation Systems Cornerstone is the only logical choice here. Should also check the Core Decay Heat Removal Degraded, Initial Injection Heat Removal Degraded, and High Pressure Injection items on Page 1.
   D. If no cornerstone can be checked, the prior screening was probably incorrectly performed.
   E. Cornerstone identification is required for the next page in the worksheet.

B. Phase 1 Worksheets Page 2
   1. Fire Protection Problems send the inspector to the Fire Protection and Post-Shutdown SDP located in IMC 0609 Appendix F.
   2. Shutdown problems send the inspector to Shutdown Safety SDP IMC 0609 Appendix G.
   3. The safety of an operating reactor, identify the degraded areas. Mitigating Systems was the only cornerstone checked, and it should be checked here.
   4. Two or more cornerstones checked would sent the inspector directly to phase 2.
   5. Continue to the appropriate column below. Note: Although this scenario only affects the Mitigating Systems Cornerstone, the other columns will be discussed to introduce the student to the worksheet.
   6. Initiating Events Column.
      A. Does the finding contribute to the likelihood of a Primary or Secondary System LOCA initiator?
         1. Secondary LOCA is a steamline break.
         2. Primary LOCA would also include a steam generator tube rupture.

3. As an example, assume the inspector notices an unusual increase in steam generator loose parts monitor channel.
4. If answer is yes, then Phase 2 is implemented.
5. If the answer is not, then next question is examined.

B. Does the finding contribute to both the likelihood of a reactor trip AND the likelihood that mitigation equipment or functions will not be available?

1. Switchyard work might be an example of this situation if the work increased the probability of a LOOP and affected offsite power sources.
2. If the answer to this question is yes, then phase 2 is implemented. if the answer is no, the next question is addressed.

C. Does the finding increase the likelihood of a fire or internal/external flood?

1. Example: Procedural deficiency in maintenance procedure could cause flooding of safety related equipment.
2. If answer is Yes, use Individual Plant Examination for External Events (IPEEE) for input into phase 3. Phase 3 will require input from NRC risk experts.
3. If the answer is no, the issue is screened as GREEN.

7. RCS or Fuel Barrier

A. RCS Barrier issue is an immediate entry into Phase 2.

B. Fuel Barrier is screened as GREEN. Performance Indicator for RCS Activity provides assessment input.

8. Containment Barriers

A. Does the finding <u>only</u> represent a degradation of the radiological barrier function provided by the control room, or auxiliary building, or spent fuel pool, or StandBy Gas Treatment (SBGT) system (BWR)?

1. Degradation of barrier does not mean that a release will occur.
2. If the answer is yes, then the finding is screened as Green
3. If the answer is NO, the next question is asked.

B. Does the finding represent a degradation of the barrier function of the control room against smoke or a toxic atmosphere?
   1. A YES answer immediately sends you to Phase 3.
   2. A NO answer sends you to the next question
C. Does the finding represent an actual open pathway in the physical integrity of reactor containment or an actual reduction of the atmospheric control function of the reactor containment?
   1. Open pathway could lead to containment bypass.
   2. Containment control functions are temperature, pressure, and combustible gas control.

9. Mitigating Systems Questions. These apply to the postulated finding.
   A. Is the finding a design or qualification deficiency confirmed not to result in loss of function per GL 91-18?
      1. GL 91-18 is a generic letter to the utilities covering degraded but functional equipment.
      2. Example: Assume the surveillance requirement for a safety-related pump is a discharge flow of 400 gpm. The pump is tested and delivers 350 gpm. Clearly, the pump cannot be called operable because it failed its test. But, suppose the licensee documents that the required flow during any accident or anticipated operational occurrence is 300 gpm. Under GL 91-18, the pump is functional.
      3. If the answer to this question is yes, then the finding is screened as green.
      4. If the answer to the question is no, the next question is examined. The answer is no for this scenario.
   B. Does the finding represent an actual loss of safety function of a System?
      1. Remind the students of the safety functions of page 1 of this worksheet.
      2. If the answer is Yes, Phase 2 is entered.

3. If the answer is No, then the next question is asked. The answer is no for the scenario.

C. Does the finding represent a loss of safety function of a single train for > its Tech Spec Allowed Outage Time?

1. Allowed outage time for HHI pumps is 72 hours. **HPCI Allowed Outage time is 14 days.**
2. If the answer to this question is Yes, then Phase 2 is entered.
3. This is the exit point for the postulated scenario, but the remainder of the mitigating system questions will be discussed.
4. If the answer is NO, then the next question is asked.

D. Does the finding represent an actual loss of safety function of one or more non-Tech Spec Trains of equipment designated as risk-significant per 10CFR50.65 for > 24 hours?

1. 10CFR50.65 is the Maintenance Rule.
2. Example of risk-significant system is the power conversion system.
3. 24 hours is "Allowed Outage Time" for risk-significant non-Tech Spec Trains. NRR decision, no risk justification.
4. A yes answer sends the inspector to Phase 2.
5. A NO answer sends the inspector to the next question.

E. Does the finding screen as potentially risk significant due to a seismic, fire, flooding, or severe weather initiating even, using the criteria on page 3 of this worksheet?

1. Page 3 Criteria, If one of these criteria is answered yes, then the inspector will be sent to Phase 3.
2. Become familiar with the plant's IPE to provide Phase 3 input.
3. IPEEE findings will not be covered at TTC.

V. Phase 2 Instructions

A. Remind the students that Phase 2 is being entered because Mitigating Systems Question 3 received a YES answer.

B. Step 2.1 - Selection of Initiating Event Scenarios

1. Enter Table 2, "Initiators and System Dependency for XXX Plant," with the equipment or safety function that was assumed to be impacted by the inspection finding. Determine the initiating event worksheets that must be evaluated.
2. Table 2 is Plant Specific.
3. Find System on left hand side of the table, move to right hand side of the table to see which Initiating Events have to be analyzed.
4. PDF file should be called up at this point.

C. Step 2.2 - Estimation of Initiating Event Likelihood

1. Enter Table 1, "Categories of Initiating Events for XXX Plant," with the exposure time associated with the finding (i.e., > 30 days, between 3 and 30 days, or < 3 days). Determine the Initiating Event Likelihood (i.e., 1 through 8) for each of the initiating events identified in Step 2.1. If the finding increases the likelihood of an initiating event, increase the Initiating Event Likelihood value in accordance with the SDP usage rules located in Attachment 2. Enter the Initiating Event Likelihood value on the applicable inspection notebook worksheet.
2. Table 2 is plant specific.
3. As shown on the table, the number in each cell is the - $\log_{10}$ of the Initiating Event Probability.
4. > 30 days is considered 1 year, 3 - 30 days is roughly 1/10 of a year, and 3 days is 1/100 of a year. Therefore, the probability changes by a factor of 10 as one travels from left to right in any row.

D. Step 2.3 - Estimation of Remaining Mitigation Capability

1. Step 2.3.1 For each of the inspection notebook worksheets identified in Step 2.1, determine which of the safety functions are impacted by the finding.
2. Step 2.3.2 Circle the sequences on each worksheet that contain one or more of the safety functions identified in Step 2.3.1. In addition, if the inspection

finding increases the likelihood of an initiating event, circle all of the sequences on the worksheet for that particular initiating event.

3. Step 2.3.3 For each safety function impacted by the finding, evaluate the unaffected equipment. Enter Table 5, "Remaining Mitigation Capability Credit," and determine the remaining mitigation capability credit for each of these functions. The Remaining Mitigation Capability credit assigned may or may not be reduced as a result of the inspection finding.
4. Table 5 is generic.
5. Step 2.3.4 Determine if the nature of the degradation is such that an operator could recover the unavailable equipment or function in time to mitigate the assumed initiating event. Credit for recovery should be given only if the following criteria are satisfied: (1) sufficient time is available; (2) environmental conditions allow access, where needed; (3) procedures describing the appropriate operator actions exist; (4) training is conducted on the existing procedures under similar conditions; and (5) any equipment needed to perform these actions is available and ready for use. If recovery credit is appropriate, enter a value of 1 in the Recovery of Failed Train column of the applicable inspection notebook

E. Step 2.4 - Estimation of Risk Significance of the Inspection Finding

1. Step 2.4.1 Determine the Sequence Risk Significance for each of the sequences circled in Step 2.3.1. **Sequence Risk Significance = (Initiating Event Likelihood + Remaining Mitigation Capability Credit + Recovery Credit)**
2. Step 2.4.2 Complete Table 6, "Counting Rule Worksheet." The result is the Risk Significance (i.e., Green, White, Yellow, or Red) of the inspection finding based on the internal initiating events that lead to core damage.

F. Step 2.5 - Screening for the Potential Risk Contribution Due to External Initiating Events

The plant-specific SDP Phase 2 Worksheets do not currently include initiating events related to fire, flooding, severe weather, seismic, or other initiating events that are considered by the licensee's IPEEE analysis. Therefore, the increase in risk of the inspection finding due to these external initiators is not accounted for in the reactor safety Phase 2 SDP result. Because the increase in risk due to external initiators may change the risk significance characterization of the inspection finding, the impact of external initiators should be evaluated by a SRA or other NRC risk analyst. Experience with using the Site Specific Risk-Informed Inspection Notebooks has indicated that accounting for external initiators could result in increasing the risk significance attributed to an inspection finding by as much as one order of magnitude. Therefore, if the Phase 2 SDP result for an inspection finding represents an increase in risk of greater than 1E-7 per year (Risk Significance Estimation of 7 or less), then an SRA or other NRC risk analyst should perform a Phase 3 analysis to estimate the increase in risk due to external initiators. This evaluation may be qualitative or quantitative in nature. Qualitative evaluations of external events should, as a minimum, provide the logic and basis for the conclusion and should reference all of the documents reviewed.

G. Step 2.6 - Screening for the Potential Risk Contribution Due to LERF

If any of the reactor safety Phase 2 SDP sequence results are greater than 1E-7 per year (sequence result 7 or less) and involve any of the sequence types listed below, then the finding should be screened for its potential risk contribution to LERF using IMC 0609, Appendix H.

- ISLOCA, Transients (includes SBO scenarios), or Small LOCAs for all reactor containment types

- ATWS for BWR Mark I and II reactor containment types

- SGTRs for all PWR reactor containment types

VI Phase 3 - Risk Significance Estimation Using Any Risk Basis That Departs from the Phase 1 or 2 Process: If necessary, Phase 3 will refine or modify, with sufficient justification, the earlier screening results from Phases 1 and 2. In addition, Phase 3 will address findings that cannot be evaluated using the Phase 2 process. Phase 3 analysis will utilize appropriate PRA techniques and rely on the expertise of NRC risk analysts.

VII. What We Have Done

A. Basic Law of Probability: If Event A and Event B are INDEPENDENT, then the probability of both Event A and Event B occurring is the product of Event A probability and Event B probability.

B. Initiating Event Probability, Mitigating System Failure Probability, and Recovery Probabilities are treated as Independent Events by the SDP.

C. Each sequence is added, i.e., the multiplication of exponents is simply the addition of the exponents.

D. The sequences are totaled on Table 6.

VIII. Cover SDP Usage Rules in Attachment 2 to IMC 0609 Appendix A.